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FORTY-FIRST ANNUAL REPORT
FOR THE CALENDAR YEAR 1951

- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula Montana

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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FORTY-FIRST ANNUAL REPORT

Introduction

During the last few years we have seen the job of looking after forest land in the Northern Rockies moving out of the custodial and into a more active stage of planned use and management. The shift from custodianship to positive management is neither new nor surprising. Forty to fifty years ago the main concern of foresters was to control fires in the vast roadless areas and guard the virgin timber until the growing lumber industry needed the logs. But as time passed, two things happened: We learned how to achieve a reasonably adequate level of fire control and the opening up of the country brought trees closer to the markets. With better fire control and markets came stronger incentives for farming our forests instead of mining them. So today, on every hand, we see signs that the great forest lands of the northern Rocky Mountain region are to be used far more intensively than many of us believed possible even ten years ago.

Forest development and utilization accelerated rapidly during 1951. The first Idaho pulp and paper mill went into production early in the year. On every side we see local groups actively promoting pulp mill developments. Pulpwood cutting and shipment to Wisconsin mills accelerated in eastern Montana. Continued high demands for pine, fir, and larch lumber favored a humming lumber industry. A new plant began turning out the first larch veneer produced in Montana. A new presto-log plant was added to those already manufacturing sawmill waste into domestic fuel. The development of Hungry Horse Dam and the potential power it will bring is already attracting industry to Montana and with it greater need for forest products.

All of these activities bring home to the research group a sharp awareness of the need to foresee the many problems that will arise in the stepped-up tempo of forest use. But we have not been unaware of the changes to come and in years past our program was formulated so that it now is paying off.

The re-survey of northern Idaho, completed in 1951, will make available sound, up-to-date resource statistics for a developing forest industry. A comprehensive forest survey report for Montana was completed during the year. A special survey of the pulpwood supply in eastern Montana has proved timely. Studies of pulping little-used species of waste materials such as alpine fir and dead lodgepole pine, recently completed, give us valuable technical information on which to base the development of a new pulp and paper industry.

Greater demands for wood and the diminishing supply of quality timber has generally focused attention on the severe losses we are suffering from insects and disease. Our research program has been geared to this problem, too, for a long time. This year especially has past work paid off. For example, the latest information on western white pine blister rust control was summarized. The subject has been under investigation in cooperation with the Division of Blister Rust Control, Bureau of Entomology & Plant Quarantine, for more than 10 years. Also in cooperation with the same agency a program of developing rust-resistant strains

of white pine has progressed rapidly with grafted stock now under field test and the seeds of control-bred pines ready for planting. In 1951 a white pine vigor classification was completed by means of which timber markers will be aided in selecting for cutting those trees most susceptible to insect attack. This project was conducted in cooperation with the Forest Insect Laboratory, Bureau of Entomology & Plant Quarantine.

The station's program has reflected the growing interest in active forest management in other ways. Within the year, tables were published for predicting the growth of residual timber left after selective cutting. One set of tables applies to the ponderosa pine type and another set to the larch--Douglas-fir type. A somewhat similar but more intensive investigation of response to partial cutting is in progress in the white pine type.

The need for information on the effective use of abandoned farm lands and the improvement of over-grazed ranges has been met by the reseeding studies begun several years ago. In 1951 a summary bulletin was prepared giving guides on what, where, when, and how to reseed such lands. More detailed studies of range stocking verified and added to earlier research to show how cows and their spring calves gained weight in relation to the intensity of stocking on short-grass ranges. Research on the removal of noxious range plants has proceeded through the pilot plant stage in some cases and many range lands not producing usable forage can now be reclaimed by eliminating the undesirable vegetation.

We well realize that our research program is inadequate in many respects. At our present pace we will be unable to keep up with the demand for more and more information that is bound to accompany the swing to intensive forest and range land use. Most disturbing is the lack of more than a token study of water resource management problems. The headwater areas of the Northern Rockies are vitally important as watersheds. The insatiable demand for hydro-electric power in the Northwest will force a maximum power development on our streams and will require sound watershed management. Soil and water values must be maintained on areas where timber, range, and wildlife resources are to be intensively produced. The technical basis for such multiple use, and all that goes with it, is entirely inadequate. We are lagging, too, in study of the management of young timber stands and how best the production of pulpwood, saw timber, poles, and other products can be integrated. Our knowledge of how best to use the 600,000 cords of logging waste and the 500,000 tons of sawdust produced each year is inadequate. The work of our cooperators responsible for research on problems of forest insects, disease, and wildlife is highly valued but like much of our forest and range program is not commensurate with the needs.

The following pages contain, in summary fashion, the major accomplishments of the year and something of our plans for 1952. We are not fully satisfied with our progress. We are proud that many studies were completed in spite of personnel reductions and assignments of several staff members to necessary projects that do not show up as accomplishments. We are proud that all of these accomplishments were made without a single hour lost because of accident--the third successive accident-free year.

In the year ahead emphasis will continue to be placed on completing projects that have been underway for some time. New work will be planned with an eye to the future--a future that is moving upon us at a rapid rate.

DIVISION OF FOREST ECONOMICS

A. Accomplishments in 1951

Forest Survey Inventory

1. The station was assigned responsibility for conducting the forest survey in South Idaho. A test survey was completed in Southeast Idaho during 1951 so that an economical survey technique best suited to that region could be developed. From survey data on a 300,000-acre test area, the relative cost and accuracy of four methods of forest type area determination will be made. Office analysis is not yet completed.

2. A beginning on the actual survey was made in Southwest Idaho where 800,000 acres of forests were inventoried. The station cooperated with Region 4, a unit of the Forest Service interested in obtaining timber inventory estimates for management planning purposes. The division made its special skills available and assured that the information collected was of maximum usefulness in the Nationwide forest survey. Our contribution was mainly one of over-all guidance in the technical aspects. However, an average of between one and two station men participated in actual field work during the 1951 season.

3. The first reinventory of North Idaho was completed in 1951 with the mapping of 1,800,000 acres in Idaho County. Reinventory in Idaho County has been difficult because of rugged terrain, lack of roads, and the preparation of a 100-percent type map. A relatively sketchy type map was made of this area in the original survey because it was believed to have little commercial future. The changed outlook in recent years has justified improving the quality of the inventory information.

4. By the end of 1951 initial field inventory of all of the northern Rocky Mountain region had been completed and about 50 percent had been resurveyed.

Item	Eastern Montana and South Dakota 1/	Northeast Washington 2/	North Idaho 3/	Western Montana 4/	Total
Type of survey	Initial	Resurvey	Re-survey	Re-survey	-
Total forest area (M acres)	8,284	4,002	10,318	14,093	36,697
Field progress inventory (M acres)					
1946-1948	6,480	4,002	4,098	-	14,580
1949	1,804	-	2,107	-	3,911
1950	-	-	2,313	-	2,313
1951	-	-	1,800	-	1,800
Total 1946-1951	8,284	4,002	10,318	-	22,604
Percent of field work completed to 12/31/51	5/ 71	100	5/ 60	-	-
Percent of total survey job completed to 12/31/51	79	100	55.8	-	-

1/ All Montana counties east of the Continental Divide except Cascade, Chouteau, Fergus, and Judith Basin. The South Dakota portion includes only Harding and part of Butte Counties.
2/ Ferry, Lincoln, Pend Oreille, Spokane, Stevens, and Whitman Counties.
3/ Idaho north of the Salmon River.
4/ All of Montana west of the Continental Divide and Cascade, Chouteau, Fergus, and Judith Basin Counties east of the Divide.
5/ Field work remaining is a detail cover type-stand class map for all or portions of these areas.

Forest Industry Analysis

5. The station collaborated with the Bureau of the Census in a survey of lumber production in 1950. We were responsible for contacting part of the sawmills in the region to determine their 1950 cut and to follow up on sawmills canvassed by the Bureau of Census that failed to report the source of their logs. The Bureau of the Census has not yet completed its compilation of the reports, so official figures are not available on lumber production during 1950. However, it appears that the final tally for the region as a whole may show a small increase over the previous census in 1948.

6. The annual surveys showed that pole, pulpwood, and Christmas tree production fell off in 1950. The Rocky Mountain Pole and Treating Association collaborated in the pole census. Pole production for the region was 35 percent less than in 1949 and pulpwood 20 percent less. Montana's Christmas tree production fared somewhat better, dropping off only 7 percent.

	1949	1950
Poles, Region 1 (number)	599,312	390,108
Pulpwood, Region 1 (cords)	113,570	90,981
Christmas trees, Montana (number)	3,256,956	3,017,780

7. Factors relating mine timber consumption to metal ore production were derived. The factors were used to estimate mine timber consumption in Montana, North Idaho, and Northeast Washington metal mines during 1949. The results of this study are published in Research Note no. 94.

8. The station participated in a Nation-wide equipment-manpower survey conducted by the Forest Service for the National Production Authority. The primary purpose of the equipment survey was to provide the National Production Authority with basic statistics as to the relation between output of forest products and equipment and supplies requirements. This information provides the basis for allocating scarce raw materials to the producers of the equipment and supplies. A sampling process was followed in which randomly selected concerns were visited by station men and the necessary data obtained by interview. Logging operations, sawmills, mine timber producers, veneer mills, pulp and paper plants, and pole producers were included in the survey. Output and manpower needs were correlated with the age distribution of the workers in various categories in another phase of the survey. The operators were also asked to enumerate the handicaps which were hampering production.

Forest Resource Analysis

9. "Forest Resources of Montana" was readied for printing during the year. This bulletin, scheduled for release through the Government Printing Office, will be printed in 1952.

Economics of Forest Management, Utilization, and Marketing

10. Sufficient green timber is available east of the Continental Divide in Montana to support six 200-ton sulphate pulp mills indefinitely. This fact and related information which comes from a study begun in 1947 will be of utmost interest to people seeking pulp mill development in eastern Montana. The study, now nearing completion, was undertaken to get the following information for that section of the State:

a. Total timber supplies available for pulping in the area (annual allowable cut).
b. Timber supplies tributary to possible pulp mill sites.
c. Cost of delivering pulpwood to the several sites.
d. Adequacy of water supply from a pollution standpoint as a factor affecting pulp mill locations.

The yield and cost aspects of the study were handled by the Division of Forest Economics with the assistance of timber management men from the national forests and the Divisions of Timber Management and Engineering of the regional office. The Forest Utilization Service took the lead in obtaining the facts about the water resource. The assistance of personnel of the Montana Power Company, the Montana State Board of Health, and the United States Public Health Service, was enlisted to study the water pollution problem. The yield and cost phases were completed during 1951 and preparation of the final report awaits only the receipt of the water resource data from the United States Public Health Service.

We find that a 4-million-acre area east of the Continental Divide, wherein the principal pulpwood opportunity appears to lie, has a maximum allowable green timber cut at the present time of about 1,000,000 cords a year. Of this volume no more than 759,000 cords should be considered as available for pulping. As previously stated, however, that is sufficient wood to support six 200-ton sulphate mills. Montana's extensive stands of dead lodgepole pine provide an additional volume of wood which can be used for pulping. Following is the annual green pulpwood cut tributary to four possible mill sites in eastern Montana:

	Cords
Three Forks	442,000
Livingston	127,100
Helena	90,600
Great Falls	81,000

11. A companion study of pulpwood supplies in western Montana, North Idaho, and Northeast Washington was started in 1951. It will follow the same general pattern of the eastern Montana study with the exception that we do not plan to analyze production costs.

B. Plans for 1952

Forest Survey Inventory

1. The data from the test survey in Southeast Idaho will be analyzed. We feel that the findings of the study will have sufficient general interest to justify publishing them in a station paper.

2. Virtually all survey field work in 1952 will be concentrated in South Idaho in cooperation with Region 4 and the Intermountain Forest and Range Experiment Station. As in 1951 the over-all guidance of the technical phases of the survey will be the responsibility of the Northern Rocky Mountain Station. Actual conduct of field operations will be the responsibility of Region 4. Transfer of a survey man to the Intermountain Station now brings that organization into the picture and makes it possible to start building up a file of Forest Survey statistics for that region at the Intermountain Station, just as the Northern Rocky Mountain Station has become the principal repository for forest statistics for the Northern Rocky Mountain Region. This three-way arrangement has been deemed both cheaper and more efficient than setting up a whole new Forest Survey organization at the Intermountain Station.

3. Since field work in Idaho County has been completed we plan to push the compilation of the resurvey for North Idaho. Final statistics should be available for this area by the year's end.

Forest Industry Analysis

4. The annual surveys of Christmas tree and pulpwood production will be continued. In cooperation with the Rocky Mountain Pole and Treating Association we will also conduct a survey of 1951 pole production.

Forest Resource Analysis

5. The publication, "Forest Resources of Montana," is expected to come off the Government Printing Office press early in 1952.

6. A statistical report, Forest Statistics for North Idaho, will be prepared. This will be released as a station paper.

Economics of Forest Management, Utilization, and Marketing

7. Analysis of the pulpwood situation in eastern Montana will be completed and a report prepared. This report will be published as a station paper.

8. The principal economic activity during 1952 will be the study of pulpwood opportunities in the Inland Empire. The job will require adjustment of relatively old timber inventory data even in North Idaho and Northeast Washington. (The newer resurveys are not sufficiently accurate by counties.) Resurvey information will be used to adjust original data. Until very recently the Forest Survey paid relatively little attention to dead timber volumes. Because dead timber has become significant as potential pulpwood, it will be sampled lightly to get an estimate of the quantities available.

Present plans call for analyzing the streams of the Inland Empire from a pollution standpoint very much as we did in eastern Montana. We plan to call in the United States Public Health Service and state health departments in this phase of the work.

DIVISION OF FOREST MANAGEMENT RESEARCH

A. Accomplishments in 1951

1. Major emphasis was given to studying means for reduction of timber losses caused by insects and diseases. When forest pests become epidemic, they often can be controlled only at great expense and with much loss of forest growth. For many kinds of serious damaging agents, the best hope for efficient control lies in the development of silvicultural methods to prevent successful attacks. Accomplishments on projects concerned with silvicultural control of serious forest pests in which the station is engaged are described below:

(a) During 1951, a manuscript for a major Department publication, which summarizes present knowledge of silvicultural methods for aiding in the control of blister rust, was completed and submitted for review and publication. A project conducted jointly with the Bureau of Entomology and Plant Quarantine has shown how the rust's alternate hosts, the ribes plants, can be greatly reduced in numbers by a variety of silvicultural operations including harvest cutting methods and slash disposal. Although cutting and slash disposal methods alone cannot wholly eliminate ribes and prevent blister rust, they offer much promise for reducing the cost and difficulty of direct control methods. Also, during 1951, a logging operation on Deception Creek Experimental Forest (Idaho), where two methods of control will be tested, was completed up to the stage of slash disposal.

(b) Development of blister rust resistant strains of white pine continued. This program is in cooperation with the Bureau of Entomology and Plant Quarantine, the California Forest and Range Experiment Station, and the Northern Region, U.S.F.S. During 1951 our part in the project included assisting in artificial pollination of native resistant trees, assisting in field planting of grafted trees with resistant scions, preparing experimental designs, observing silvical characteristics of the subject trees, and a variety of other tasks.

(c) A vigor classification for mature western white pine as an aid to timber markers was completed. This project was conducted jointly with the Bureau of Entomology and Plant Quarantine. A classification system has been developed, illustrated by the accompanying table, by which the ability of mature trees to grow and to resist destruction by damaging agents can be predicted with a fair degree of accuracy. The table will help timber markers to decide which individual trees and which stands should be cut first. The project was begun in 1941.

(d) Silvicultural aspects of pole blight were studied. The station cooperates on a comprehensive pole blight project with the Bureau of Plant Industry, Soils & Agricultural Engineering; University of Idaho; National Forest Administration; Bureau of Entomology and Plant Quarantine; and the Dominion Laboratory of Forest Pathology (Canada). The objects of the project are to determine the cause and possible

VIGOR CLASSIFICATION FOR MATURE 1/ WESTERN WHITE PINE TREES

C. A. WELLNER AND J. C. EVENDEN 2/

CHARACTERISTICS 3/	EXCELLENT	GOOD	FAIR	POOR
CROWN CLASS	CODOMINANT	CODOMINANT	INTERMEDIATE	SUPPRESSED
CROWN DENSITY	GOOD	ORDINARILY GOOD, OCCASIONALLY FAIR	ORDINARILY FAIR, OCCASIONALLY POOR, RARELY GOOD	USUALLY POOR, OCCASIONALLY FAIR, RARELY GOOD
LIVE CROWN LENGTH IN PERCENT OF TOTAL TREE HEIGHT	(LONG) USUALLY 50 OR MORE 40 ONLY IF CROWN WIDTH IS MORE THAN AVERAGE	(AVERAGE) 30-50 30 IF OF GOOD DENSITY AND AVERAGE OR GREATER WIDTH; 40-50 IF OF FAIR DENSITY AND AVERAGE WIDTH; MORE THAN 50 IF GOOD DENSITY AND NARROW	(SHORT) 20-30 20-30 IF OF FAIR DENSITY AND AVERAGE WIDTH; 30 IF OF GOOD DENSITY BUT NARROW; OVER 30 IF (A) AVERAGE WIDTH AND POOR DENSITY, OR (B) NARROW	(VERY SHORT) 20 OR LESS MORE THAN 20 IF POOR IN OTHER RESPECTS
CROWN WIDTH	AVERAGE OR WIDER	USUALLY AVERAGE, OCCASIONALLY NARROW	USUALLY NARROW TO AVERAGE	USUALLY NARROW TO AVERAGE
CROWN COLOR	HEALTHY GREEN	HEALTHY GREEN	HEALTHY GREEN	GREEN OR YELLOWISH
TIP VIGOR 4/	GOOD	FAIR TO GOOD	POOR TO GOOD	USUALLY POOR TO FAIR, IF TIP VIGOR AND CROWN DENSITY ARE BOTH POOR, PLACE IN THIS CLASS.
DEAD BRANCHLETS OR BRANCHES IN UPPER CROWN	INFREQUENT	SPARSE OR ENTIRELY ABSENT	MODERATE FREQUENCY	ABUNDANT

1/ GENERALLY OVER 100 YEARS IN AGE.

2/ U. S. DEPT. OF AGRICULTURE, FOREST SERVICE, AND BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, RESPECTIVELY.

3/ DESCRIPTION OF CHARACTERISTICS FOR EACH VIGOR CLASS GENERALLY STATE THE LOWEST POSSIBLE OR LIMITING CONDITION.

4/ JUDGE MORE BY SHOOT ELONGATION THAN BY PROFILE SHAPE.

methods of control. Despite a concerted effort by several agencies, the cause is still unknown and each year new and more widely spread infection areas are being found. (In 1951 it was found for the first time in the Pacific Coast region--on Vancouver Island.) In June 1951 the station again called a conference of the cooperating agencies. The meeting was held at Priest River Experimental Forest, where one day was devoted to plans and methods and one day to a field review of an experimental study area. Later in the summer the station, in cooperation with the Kaniksu National Forest, completed cutting on a timber sale where pole blight infected trees are being removed to determine the effect on further spread of infection.

2. Tables for predicting growth in selectively cut mature ponderosa pine and larch--Douglas-fir stands were published. The tables will be used by forest managers both for calculating expected yields in selectively cut timber stands and for determining the intensity of cutting which will produce the greatest growth. The attached table illustrates some of the basic information in Station Paper 32 which deals with ponderosa pine growth. Instructions and additional tabular data are given for adjusting growth predictions for site quality, stand age, ingrowth, and other factors. Growth of larch--Douglas-fir stands is described in a similar Station Paper, number 30.

3. The study of sample tree measurement was completed and findings were published. The study showed how sampling can be used on tree measurement sales in the Northern Region to reduce labor and maintain desired standards of accuracy. The final report (Station Paper 27) contains a detailed job breakdown that the Regional Training Officer helped prepare. The job breakdown is intended to guide men who are inexperienced in statistical procedures to plan and conduct sample tree measurement operations.

4. The installation of the western white pine partial cutting plots was completed. Between 1941 and 1951 the station installed sample plots in nine timber sales partly on Deception Creek Experimental Forest and partly on national forests throughout North Idaho for the purpose of collecting information on the response of mature and overmature western white pine to partial cuttings. Partial cuttings in mature white pine are intended primarily to accomplish one or more of several purposes:

   (a) To "bug-proof" by removing trees which are likely to be attacked by dendroctonus beetles.
   (b) To induce futile germination or devitalization of ribes seed.
   (c) To salvage trees that are deteriorating in value.
   (d) To harvest trees that are subject to uprooting, snow breakage, or other mortality.
   (e) To increase the vigor and growth of the remaining stand.
   (f) To make more timber accessible for future salvage and harvest cutting.

Periodic examinations of plots will show the net results of the cutting.

5. A Christmas tree management experiment was begun. The purpose of the experiment is to learn by trial over a period of years the actual yields, operational methods, and costs from systematic management of a tract for production of Douglas-fir Christmas trees. The test plot is a 30-acre tract on the Nine Mile District, Lolo National Forest. The local district ranger, Extension Forester, and Soil Conservation Service representatives are assisting in the project. In 1951, the first year of the test, slightly over 1,000 trees were harvested, almost 1,000 trees were planted to fill openings, and about 10 man-days were spent on various stand improvement operations.

6. Salvage cuttings on Deception Creek Experimental Forest are demonstrating the effectiveness of an intensive permanent utilization road system. Much of the experimental forest has been made readily accessible by carefully planned operator-built logging roads which were constructed during timber sales between 1937 and 1942. Today these roads are proving of much service for salvaging timber that has been damaged or destroyed by extraordinarily severe wind, snow, and insect injury and unexpectedly rapid deterioration of certain stands. Salvage cuttings during the past four years are summarized below:

Year	Volume (M ft. b.m.)	Stumpage
1948	134	$ 2,999
1949	358	8,244
1950	649	12,320
1951	2,737	38,797
Total	3,878	$62,360

If the utilization roads had not been originally planned as parts of a unified permanent system, much of the recent salvaging would have been impracticable and both total timber removal and stumpage rates would have been materially reduced.

7. An experiment to test three methods of cutting overmature larch--Douglas-fir was installed on the Coram Experimental Forest in Montana. About 1,800,000 board feet of timber were logged under regular timber sales procedure in order to compare seed tree, shelterwood, and economic selection methods. Three kinds of slash disposal are also being tested. The purpose is to determine how larch reproduction can be encouraged. As an important byproduct of the study, logging costs are being analyzed to determine the financial aspects of the different marking methods.

Table 4. Gross board-foot volume growth per acre of ponderosa pine residual trees, Scribner rule, following selective cutting 1/, by basal area reserve stand classes 2/, average site quality and age.

Basal area of reserve stand at time of cutting	Volume after an interval of									
	5 yrs.	10 yrs.	15 yrs.	20 yrs.	25 yrs.	30 yrs.	35 yrs.	40 yrs.	45 yrs.	50 yrs.
Sq. ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.	Bd.ft.
10	3/ 130	330	520	740	940	1160	1380	1610	1820	2030
15	190	450	710	990	1260	1540	1810	2090	2360	2620
20	250	570	900	1250	1590	1920	2250	2570	2890	3200
25	310	690	1090	1510	1910	2300	2680	3060	3430	3780
30	370	820	1270	1760	2230	2680	3120	3540	3960	4370
35	430	940	1460	2020	2560	3060	3550	4020	4490	4950
40	490	1060	1650	2280	2880	3440	3980	4510	5030	5540
45	550	1180	1830	2540	3200	3820	4420	4990	5560	6120
50	610	1310	2020	2790	3530	4200	4850	5470	6100	6700
55	670	1430	2210	3050	3850	4570	5280	5960	6630	7290
60	730	1550	2400	3310	4170	4950	5720	6440	7170	7870

1/ All trees 9.6 inches d.b.h. and larger are included.
2/ Basal area is computed on trees 9.6 inches d.b.h. and larger in the reserve stand.
3/ To correct the values in this table for mortality, reduce by 15 percent or multiply by the conversion factor 85 percent.

Basis: 60 one-half acre plots.

B. Plans for 1952

1. Complete major analysis of growth in immature western white pine stands and prepare final reports. We believe the growth records collected on sample plots in uncut white pine stands during the past 25 years will provide a basis for correcting the normal yield tables and also will show how growth for understocked and overstocked stands can be predicted. After completion of the analysis, the sample plots will be considered for possible changes in remeasurement schedules or for termination.

2. Complete major analysis of all thinning experiments. The station's numerous thinning experiments, chiefly in the western white pine type, are being analyzed on a uniform basis to determine the results to date. Some of the plot records extend back to 1914. After completion of the study the plots will be considered for revision of measurement schedules or termination. The final reports probably cannot be completed during 1952.

3. Complete installation of prescribed burning, slash disposal experiments on Deception Creek and Coram Experimental Forests. The Deception Creek broadcast burning is a key step in a method of blister rust control which is being tested. The Coram burning is intended to test one of the apparently cheaper and more promising methods of regenerating larch. Both burning operations are rather dangerous and costly tasks, about which more knowledge is needed. Much significance is attached to their successful accomplishment. Cooperation from national forest personnel is required.

4. Complete installation of the ponderosa pine second-growth sawlog farm woodland cuttings and begin a similar series in pulpwood-size timber. Five series of plots have been established under memorandums of understanding and logging has already been completed on four of the five. A new series of similar cuttings will be started in 1952, but with the difference that smaller timber will be the subject and pulpwood will be harvested.

5. Prepare up-to-date and comprehensive problem analyses for both the Inland Empire and Upper Columbia problem areas. During 1952 and 1953 the Inland Empire Research Center will terminate or substantially lessen work on several major projects concerned chiefly with western white pine. The time, therefore, is appropriate for a general review before undertaking new work of major importance. In general, current thinking favors placing more emphasis upon associated species, some increase in emphasis upon silvics and genetics, and some broadening of scope to encompass the relationship of silviculture to watershed management. Completion of the analysis may extend into 1953 but the bulk of the work will occur in 1952. In the Upper Columbia problem area investigative work first began in 1946. To date the research program has been guided by preliminary analyses which were never fully completed. We now believe we can prepare a comparatively mature and comprehensive program which will permit more specific and more thorough

advance planning. In general, it is likely that major emphasis will be directed to the ponderosa pine and larch--Douglas-fir types. However, in both problem areas the detailed analyses and subsequent reviews may lead to conclusions more or less at variance with the activities which have been indicated.

6. Install block clear cutting experiments and begin preparation of strip clear cutting in larch--Douglas-fir at Coram Experimental Forest. With the addition of the proposed new experiments to the seed tree, shelterwood, and economic selective cuttings already present, Coram Experimental Forest will possess examples of a rather complete series of major harvest cutting methods for both research and demonstrational purposes.

7. Continue projects designed to reduce timber losses caused by insects and diseases. The major items in the category of silvicultural control are pole blight studies, breeding blister rust resistant white pine, and reduction of ribes.

DIVISION OF RANGE RESEARCH

A. Accomplishments in 1951

Artificial Range Revegetation

1. Up-to-date guides as to what, where, when, and how to reseed, and the justification for reseeding to increase the yield of Montana range lands were set forth in a major revision of U.S.D.A. Farmers' Bulletin no. 1924. The bulletin, when released in 1952, will make available new information on species and methods for use on depleted and formerly plowed range lands of the plains, foothills, valleys, and mountains of the northern Rocky Mountain region.

2. Spring planting on clean seedbeds in forage species nurseries has been superior to fall planting during the past two years at three locations in northeastern Washington. Dry, early fall periods followed by heavy precipitation and severe winter weather probably caused winter killing of tender seedlings resulting from fall plantings. Several species of wheatgrass produced good stands from spring plantings at all locations. Only standard crested wheatgrass made any showing from fall plantings.

3. Fair to good seedling stands were secured from fall seeding of seven grass species in new grain stubble on 4.2-acre areas at Fort Missoula. Species in descending order of stand secured were: hard fescue, big bluegrass, crested wheatgrass, intermediate wheatgrass, bluestem wheatgrass, stiffhair wheatgrass, and green needlegrass.

4. Seedling stands of reseeded species on sagebrush land were almost doubled by thorough ground preparation in a test conducted in cooperation with National Forest Administration and the Beaverhead National Forest. In a heavy big sagebrush type at 7,000 feet elevation in southwestern Montana, plots which had been triple disked with an offset disk harrow and broadcast seeded produced on the average about 142,000 seedlings per acre as compared to 77,000 on comparable single disked plots. This relationship was consistent for all species included. In addition, number of stems per seedling was also greater on the triple disked plots, indicating more favorable growing conditions. The three consecutive diskings in the same direction, used in the test, were no more effective in disturbing the soil than disking twice at right angles. Therefore, under similar field conditions, two consecutive diskings may be the most desirable practice, especially if expensive seed is being used.

   The study also verified previous observations that 75 to 80 percent of a big sagebrush stand can be killed by a single treatment with the offset disk harrow. Triple disking killed almost all of the sagebrush and native bunchgrass. Kill from this spring disking was as great or greater than from fall disking on a comparable site in 1949.

5. Eight out of forty forage species and strains tested for 10 years at an elevation of 9,350 feet in southwestern Montana seemed well adapted to the site and to weather conditions which prevailed. These are: Commercial and Parkland strains of smooth bromegrass, meadow foxtail, meadow brome, Kentucky bluegrass, violet and common slender wheatgrasses, and bearded wheatgrass. Tall oatgrass, meadow fescue, timothy, and orchardgrass, sometimes recommended for high mountain areas, performed poorly on this open site. The Fairway strain of crested wheatgrass, although not to be recommended from performance in this test, maintained its stand longer than the standard strain. Except for severe winterkill last year sheep fescue appeared highly promising. The importance of selecting the proper strain, especially among native species, was illustrated by complete failure of such natives as Idaho fescue and mountain brome from seed collected at lower elevations. Of the 40 species and strains planted, only meadow foxtail is positively known to have reseeded itself.

6. Preplanting seed treatments were found to enhance seed germination and seedling emergence in certain native browse species.

Seed treatment	Red-osier dogwood	Antelope bitterbrush	Redstem ceanothus	Snowbrush ceanothus	Saskatoon serviceberry	Western chokecherry	Rocky Mountain maple
	Percent emergence						
Exposed to winter conditions for 87 days	69	1	2	0	0	3	0
Scarified and exposed to winter conditions for 87 days	30	0	0	1	0	1/	1/
Stratified for 90 days	87	36	0	0	0	4	2
Scarified and stratified for 90 days	67	31	18	10	4	1/	1/
Hot water bath 30 minutes and stratified for 90 days	20	8	14	7	0	9	1

1/ Not given these treatments.

Emergence percentages under greenhouse conditions show that the species responded differentially to the various preplanting treatments. Stratification was beneficial to at least two of the species and in

combination with other treatments was best for the two species of Ceanothus. Poor germination of serviceberry, chokecherry, and mountain maple was attributed to their requirement of a longer stratification period. The apparent critical pretreatment requirements for all of these species point up the futility of field planting in the spring with untreated seed. Success of fall planting would probably be haphazard due to the wide variations in afterripening conditions which occur. Therefore, proper pretreatment followed by spring field planting appears to be the procedure most likely to give success.

Management of Summer Ranges

7. Mixed stock cattle on national forest summer range used more salt in late summer and fall than in early summer during 1951. During June, the first months of the grazing season, the cattle used less than half a pound of block salt per head. In August the average amount used was 1.7 pounds per head, and in October it was 1.2 pounds, 2.7 times the rate of use for June. This pattern of salt use in relation to season has held for several years and is similar to the pattern determined on northern Great Plains ranges. When granulated rock salt was used on the same summer range grazed by cows with calves total consumption was about double the 1951 figure.

8. High mountain summer range in fair to good condition and conservatively stocked produced $4.50 worth of marketable beef per acre during 1951. Considering the prices received for cattle marketed out of the Vigilante Experimental Range at the end of September and the total season-long change in weight of all animals grazed, the 4,000-acre experimental range produced about $18,000 worth of beef during a 5-month grazing season. Mixed steers gained 303 pounds on the average; heifers, 306 pounds; and dry cows, 327 pounds. At prices received these gains were worth $100, $85, and $87 per head, respectively.

Management of Short-Grass Ranges

9. The basic plan of research was reoriented to provide ultimately an evaluation of vegetation and soil characteristics as criteria for judging condition and trend of range as a consequence of grazing. Sensitivity of range characteristics as well as the kind, direction, and degree of changes from normal, their import, and the intercorrelation of character changes were included for study. This modification of attack was needed because factual and critical guides for insuring maximum sustained forage on Plains ranges through proper grazing still are far from complete. On immense acreages such guides are the only means by which the goal of maximum forage production may be achieved.

10. Growth of range breeding cows and their spring calves during 1950 and 1951 more clearly reflected rates of range stocking on experimental range pastures stocked at the same rates for 15 years than did earlier lots of cows and calves. The experimental ranges were stocked in May 1948 with yearling heifers at the established rates of 23.1, 30.5, and 38.8 acres per animal unit yearlong, the same rates at which the ranges had been stocked since 1933. Since 1948 two crops of calves have been produced. Comparative growth of both cows and calves under the three rates strongly support the concept that body size of animal is in a large part an expression of dietary level. In other words, the weight gains by cows and calves in this study were correlated with abundance of forage in the different pastures.

Average summer weight of cows

Year	Stocking rate: Heavy grazing	Moderate grazing	Light grazing
	---- pounds ----		
Initial spring weight, 1948 [1/]	458	453	460
1948	630	640	651
1949	795	826	853
1950	898	949	988
1951	918	1,006	1,055

1/ For yearling heifers

Average calf weight, mid-May through weaning 1/

Date	Stocking rate: Heavy grazing	Moderate grazing	Light grazing
	---- pounds ----		
May 17	114	122	127
June 14	155	167	181
July 12	207	220	238
Aug. 9	261	276	297
Sept. 6	307	328	347
Oct. 5	339	377	395
Oct. 20	350	397	420

1/ Composite of 1950 and 1951 calf crops.

Noxious Plant Control

11. When unrefined borax ore, commonly called "borascu," was applied in the spring to Klamath weed-infested range land it reduced the Klamath weed and enabled forage grasses to thicken. In 1951 range plots treated two years ago with borascu at the rate of 640 pounds per acre, had less Klamath weed and more native grass density. On nearby untreated plots Klamath weed was considerably denser but native grass density was only moderate compared to 1949. Bluebunch wheatgrass plants were more vigorous on the treated areas as evidenced by their taller growth, the greater percentage of plants bearing seed stalks, and the larger number of seed stalks per plant.

Estimated plot density in square feet 1949 and 1951

Area	Klamath weed		Bluebunch wheatgrass		All grasses	
	1949	1951	1949	1951	1949	1951
Treated	13.5	4.4	1.3	3.3	7.1	23.5
Untreated	7.4	9.6	3.1	4.5	4.5	8.6

Although borascu is costly and its application difficult and time-consuming, these data indicate its usefulness in treating Klamath weed areas, especially small invasion outposts which justify immediate, positive handling.

12. Commercial herbicides applied as contact sprays in mid- or late summer gave satisfactory control of mulesears wyethia. "Weedone," a commercial herbicide having a formulation of 2,4,5-T and 2,4-D in mixture was most effective.

Herbicide and concentration in spray	Formulation	Percent of plants killed
Weedone, 10,000 ppm) Weedone, 6,000 ppm)	11% butoxy ethenol ester of 2,4,5-T and 23% of butoxy ethenol ester of 2,4-D	94.6
Weed-no-more, 10,000 ppm	40% Butyl acetate of 2,4-D	89.2
Esteron 44, 10,000 ppm	44% Isopropyl ester of 2,4-D	82.7
Root cut 6 inches below ground line		79.0
Malic hydrazide, 10,000 ppm	30% solution	58.8
Diesel oil, undiluted		51.3
Root cut at ground line		8.0

2,4-D = 2,4-Dichlorophenoxyacetic acid.
2,4,5-T = 2,4,5-Trichlorophenoxyacetic acid.

Two other 2,4-D formulations were nearly as effective as the Weedone. The effectiveness of single applications of the herbicides increased with delay in date of application and consequent stage of maturity of the plants. No advantage of multiple over single applications was found.

B. Plans for 1952

Artificial Range Revegetation

1. Continue over-all analysis of reseeding observations and data now on hand with a view to evaluating planted species from the standpoint of: (a) ease of establishment, (b) resistance to competition, and (c) range of adaptability. This analysis will also serve as a factual basis for project analysis planning.

2. Plan and execute, in cooperation with a local rancher, a study to determine first year effects of the removal of big sagebrush by roto-beater on understory vegetation. This study was requested by National Forest Administration and the Extension Service. It can be conducted near Missoula with a very small outlay of time and effort.

3. Replant grass species for pure stands on Bremner ranch in northeastern Washington and determine success of the seeding. Follow up the Missoula phase of this study to determine winterkill, survival relative to quack grass competition, and herbage production.

4. Follow up 1951 sagebrush removal and reseeding study on Dry Fawn Creek, Beaverhead National Forest. Two examinations of plots will be necessary to determine winterkill of grass seedlings and the over-all effects of treatments on herbage production. Sagebrush treatments include burning, spraying, and three intensities of disking.

5. Initiate a study in Carrot Basin on the Gallatin National Forest to determine suitable methods and adapted species for reseeding deteriorated subalpine sheep range. This study will be cooperatively conducted with the Gallatin National Forest and National Forest Administration.

6. Compare herbage production of crested wheatgrass in stands of different ages and subjected to various treatments. Treatments will include mechanical thinning of old stands with and without fertilization, destruction of old stands, and reestablishment of stand with and without fertilization. How to renovate successfully old, deteriorating stands of crested wheatgrass is a subject of concern to many land administrators in Montana.

Management of Summer Ranges

7. Restock the Vigilante Experimental Range with mixed cattle at about the 1951 level. All cattle entering the area will be tagged and weighed individually at the start of the grazing

season. Part of the herd will be weighed periodically throughout the summer and the weight of all animals will be recorded as they leave the area. This study will show the seasonal weight trends of cattle, by classes, on summer range, total gains of the cattle, and production from the area over the season.

8. Continue the use of salt on the Vigilante Experimental Range as a means of promoting uniform grazing use over the area. Also, more data are needed to describe the seasonal pattern of salt use. In the past and contrary to early published information on salting, cattle have taken more salt in late summer and fall when the forage was curing than during the early summer when forage was lush and green.

Management of Short-Grass Ranges

9. Develop adequate sampling schemes and plans for studies on experimental ranges. A range sampling method for use in the Miles City cattle pastures is needed for sound evaluation of soil conditions and total herbage production. Sampling techniques essential to other range analyses will be developed.

10. Continue stocking the experimental cattle ranges but replace four of the breeding cows in each intensity of stocking with an equal number of heifer offspring, from the respective lots, which are approaching breeding age. These replacement animals are the first members of the first filial generation to go back into the generation study now under way. Since weaning they have been subjected as closely as possible to the same stocking treatments that the established intensities provide.

11. Complete revision of first draft of the manuscript "Response of cattle and range to stocking rate in the northern Great Plains."

Noxious Range Plant Control

12. Initiate a study, possibly in cooperation with the University of Idaho, of the ecology of Klamath weed (Hypericum perforatum) and of the Klamath weed beetle (Chrysolina gemellata and C. hyperici). The control of Klamath weed by any method and the successful establishment of the Klamath weed beetles, which offer the most promise as a measure of control, depends largely upon the development, through research, of complete ecological knowledge of both the plant and the beetle.

13. Determine the feasibility of reseeding following the application of herbicide sprays over Wyethia infested ranges. This study will complete the field work in connection with the Wyethia pilot test initiated in 1951. Preparation of a final report and recommendations for National Forest Administration on Wyethia control will be completed within the year.

14. Studies of the growth and development of larkspur (Delphinium glaucescens) will be expanded as a basis for the development of control measures. Larkspur is a deterrant to efficient and best use of some national forest range areas. To date all efforts to control this undesirable plant with herbicide sprays have failed. This failure has been attributed to incomplete knowledge of the life history and growth habits of this plant.

DIVISION OF FIRE RESEARCH

A. Accomplishments in 1951

1. Analysis of 36,000 fires provided new information for fire control planning and management. In April 1951 Station Paper No. 28, "Forest Fires in the Northern Rocky Mountains," was issued--a 252-page, illustrated report presenting results from a 4-year study of 36,000 forest fires. It provides fire control men with a mass of basic information needed in the design of fire control systems, management of fire control organizations, and suppression of going fires. The report summarizes fundamental requirements for effective and economical fire control. In addition, it presents background material for a better understanding of fire behavior, fire prevention, and fire control methods. Highlight of the study is the information showing the great variations in northern Rocky Mountain fire conditions and the conclusions which emphasize the need for highly flexible fire control organizations. One of the important benefits of this study is the foundation of basic information which is now available for future research projects.

2. New fire behavior guides were prepared for fire control forces. After the 1950 national fire conference the station's Division of Fire Research was assigned the job of preparing guides to aid fire-control men in making reliable estimates of fire behavior. There are still many unknowns in fire behavior which must be investigated in future research. However, as a result of years of studies of various aspects of fire behavior, the station was equipped with much useful information and was in a good position to summarize key facts now known. Accordingly, Station Paper No. 29, "Fire Behavior in Northern Rocky Mountain Forests," was issued in May 1951. This is a 120-page, illustrated handbook summarizing important facts on the ignition, rate of spread, and general behavior of forest fires in this region. Incorporated in the publication are several tables and keys for use by dispatchers and fire-goers in making estimates of weather, topography, and fuels and their effect on rate of spread of fires.

3. Guides are now available for estimating burning index at the site of a fire. Field studies made at the Priest River Experimental Forest, previously reported, have shown how fire-weather factors vary according to altitude, aspect, and time of day. The analysis of several thousand Forest Service fires, for which weather and topographic factors were known, enabled tests to be made of

variations in rate of spread according to burning index. As a result of these studies burning index was shown to be an important guide to fire behavior, and especially so where proper conversions could be made to compensate for the effects of altitude, aspect, and time of day. Accordingly, a series of conversion tables were prepared showing how to estimate burning index at the site of a fire on the basis of fire-weather measurements made at a valley-bottom or mountain-top station. Research Note No. 100, "Correction of Burning Index for the Effects of Altitude, Aspect, and Time of Day," issued in June 1951, explains the use of the conversion tables.

4. Fuel rate-of-spread classification keys show how to recognize five major fuel types. Our original fuel classification system recognized four rate-of-spread classes known as low, medium, high, and extreme. Rate-of-spread studies of over 5,000 fires have shown that this system may be improved by identification of flashy fuels as a separate type. Accordingly, the fuel classification system has been revised to include a fifth rate-of-spread type known as "flash." To assist in identifying all of the five rate-of-spread types a series of guides, similar to botanical classification keys, have been prepared. These keys enable conditions observed in range land, brush fields, dense coniferous forests, open coniferous forests, subalpine and spruce forests, or cut-over forests to be translated in terms of fuel rate-of-spread classification.

5. Experimental rate-of-spread computer was tested in 1951. The rate-of-spread computer now being developed is a slide rule type device to assist dispatchers and fire-goers in making estimates of the behavior of going fires. Its function is to provide speedy integration of known fuel, topographic, weather, and time factors into a numerical expression of rate of spread. During 1951 the rate-of-spread computer was field-tested on a dozen ranger districts in Region 1. The recommendations of district rangers and dispatchers who have used the computer on going fires indicate the desirability of continuing these tests and of expanding the test program to include additional ranger districts. It is not considered feasible or desirable to attempt to develop a slide rule device which will compute exact rate-of-spread figures for every fire. However, the tests indicate that a device similar to the present experimental computer is a valuable training guide which may improve the accuracy of fire behavior estimates. When using the computer, fire men follow a systematic process for evaluating important fuel, topographic, weather, and time factors as essential aids in estimating fire behavior.

6. Region 1, Weather Bureau, and Station joined forces in 1951 to improve the fire danger rating system. Experience has shown that the network of nearly 200 fire danger stations in this region requires constant attention to insure a high standard of operation and maintenance. During the past year Region 1, the Weather Bureau, and the Station established a joint project to inspect fire danger stations, maintain and repair fire-weather instruments, train fire danger station operators, and plan relocation of stations

where necessary. During the year over 100 fire danger stations were inspected. An instrument shop was established at Missoula for the repair and calibration of fire-weather instruments. Work was started on a fire danger rating atlas which will show locations and other pertinent details for a revised network of fire danger stations.

7. Fuel moisture studies are pointing the way to an improved system of fire danger rating. The Northern Rocky Mountain burning index meter steps up ratings by calendar date to compensate for the progressive drying of herbaceous vegetation. In a normal year this system works satisfactorily, but in a dry year it may rate burning index too low and in a wet year too high. Progressive drying and curing of herbaceous vegetation may be indicated by several different types of measurements. Tests are being made to determine which of these systems, if any, will provide a reliable measurement of this important factor. During the past year studies were continued at the Priest River Experimental Forest of the moisture content of large logs as related to the moisture content and rate of curing of herbaceous vegetation. Studies were also made at nine widely scattered stations to determine the relative merits of basswood slats and ½-inch ponderosa pine sticks as indicators of the inflammability of light, flashy fuels. These studies have not been completed, but there are indications that either basswood slats or a conversion factor applied to ½-inch sticks may provide a guide to the progressive drying of herbaceous vegetation. In addition we are hopeful that early July measurements of large log moistures may provide a basis for advance predictions. This latter possibility cannot be tested until we have experienced one or more critically dry fire seasons.

8. Resistance-to-control classification of fuels is a key factor in determining suppression force requirements and the success to be expected in control operations. Analysis of over 5,000 fires shows that man-hours required to control a fire varies from nearly 7 in low resistance fuels to 228 in extreme resistance fuels. Field studies have shown that resistance-to-control factors vary according to the type of firefighting employed. Resistance-to-control factors which may slow up a bulldozer may not cause a similar loss of efficiency to hand-tool firefighting and vice versa. Effective fire control planning requires the establishment of reliable guides for rate of held-line production for all types of firefighting. During 1951 the station tackled this key problem with the initiation of a planned 3-year study of resistance to control on a cooperative basis with a graduate student at the School of Forestry, Montana State University. Progress during the first field season included evaluation of the factors influencing resistance to control and studies on going fires of rate of held-line production.

9. Field studies show efficiency of aerial patrols in the detection of lightning fires. The decadent condition of hundreds of lookout stations and the lack of funds for necessary maintenance and new construction have forced the Forest Service to adopt new

methods of fire detection. Previous studies have shown that observers in patrol aircraft have a fair degree of reliability in fire detection. However, many specific questions vital to the planning and operation of aerial detection units remain unanswered. One of these questions is the ability of aerial observers to detect fires according to the hour-to-hour variations in sun angle. During 1951 a sunup-to-sundown test was made of aerial detection efficiency. In this test a new type of smoke bomb was used to simulate small fire conditions for detectors observing from two patrol aircraft and four ground positions. Results of this test showed a superior ability of aerial observers to detect smokes on the upper slopes of mountains during all hours of the day because they see smokes against a dark background of timber, whereas smokes on upper slopes must often be observed by ground observers against an aerial background.

10. Fire behavior factors were studied on prescribed burning projects. Management of many northern Rocky Mountain forests requires the prescribed use of fire to reduce dangerous fuels and prepare sites for planting or natural regeneration of a new timber crop. Past experience has shown that only during a relatively short period each year are conditions satisfactory for prescribed burning. Therefore, it is important that accurate fire behavior estimates be made during this short period to permit the maximum amount of prescribed burning to be conducted efficiently and safely. In addition it is possible that keen evaluation of fire behavior conditions might permit safe burning during a longer period of the year. During 1951 field studies were initiated on prescribed burns in an attempt to evaluate the key weather and fuel factors that are vital to these operations. Portable fire-weather stations were installed at several points in and around the area to be burned. Many more field tests will be needed before conclusive results will be available.

B. Plans for 1952

1. Fire behavior research will be continued. Studies during the next year will be focused on (1) behavior of prescribed fires, (2) inflammability of logging slash, (3) analysis of factors causing "blowup" fires, and (4) rate-of-spread computer tests.

2. Fire danger rating research will be concentrated on fuel moisture measurement and evaluation. Analysis of data collected in the large log, herbaceous vegetation, and basswood slat studies is scheduled as a high priority job. In addition, initial tests are scheduled of fibre glass rods for use as fuel moisture indicators. The joint Region 1, Weather Bureau, and Station project for improvement of the fire-danger rating network will be continued. Work will be started on a fire-danger rating handbook.

3. Field studies will be made of resistance to control. The cooperative project with Montana State University to evaluate the factors influencing held-line production by men and machines will be continued.

4. Results of air-ground detection studies will be analyzed and summarized. We plan to show what is now known about air-ground detection and determine importance of major unknowns. As a result of this analysis we hope to determine (1) whether publication of a new detection planning guide is now feasible, and (2) priorities for future research in this field.

5. Results of an analysis of over 200 large fires will be summarized. As a result of this summary we hope to publish a guide on the prevention and control of large fires.

FOREST UTILIZATION SERVICE

A. Accomplishments in 1951

1. Wood molasses livestock feeding experiments conducted to date in the West have proven generally satisfactory as summarized at the Northwest Wood Products Clinic. Several years ago this station started cooperative feeding experiments with the Montana, Wyoming, and Idaho Agricultural Experiment Stations. Clyde McKee, Director of the Montana Station, was designated as the coordinator of the work done in the eleven western states. Results of this coordinated experimental feeding program follow.

   a. Wood molasses, used as a constituent of grain concentrates, has been fed to beef and dairy cattle, sheep, swine, and poultry without any apparent toxic effect or serious interference with animal growth.

   b. In no case has wood molasses fed to dairy cows produced any off-flavors in milk.

   c. There is some evidence that satisfactory results from feeding wood molasses are dependent upon thorough mixing of the product with the concentrate or mixed grain ration.

   d. Cooking and palatability studies of meat from lambs and hogs fed on wood molasses feed mixtures have failed to show any undesirable flavors.

   e. Wood molasses thus far made available is apparently more palatable to sheep than to any other class of farm animals.

   f. The most serious objections to the wood molasses currently available are (1) its bitter taste, and (2) its variable quality, particularly with reference to acid content and foreign matter.

   g. Until wood molasses of a standard quality becomes readily available on the market at prices advantageous in comparison with those for other sources of carbohydrate or

high-energy feeds, most agricultural experiment stations will not conduct further tests of feeding wood molasses.

2. Water quality, availability, and pollution dangers were studied at several possible pulpmill sites in eastern Montana. As previously mentioned, this was a cooperative project, including participation by the United States Public Health Service, Montana State Board of Health, Montana Power Company, and the Station. Sites were inspected on the Yellowstone River between Livingston and Billings, and on the Missouri River between Three Forks and a point several miles below Great Falls.

   Facts were gathered on the hydrology of these rivers, the current pollution situation, and the possible conflict with other uses such as livestock raising, irrigation, recreational use, especially fishing. Hearings were conducted at Billings, Livingston, Three Forks, Great Falls, and Helena.

3. The second veneer plant and the first to produce sliced western larch veneer in the northern Rocky Mountain area started production during the year. After observing the results of several years of testing western larch for veneer production, the Polson (Montana) Lumber Company established a veneer plant in connection with its sawmill. A slicing machine with a 12-foot blade will produce green veneer to be dried elsewhere. Experiments have also proven larch suitable for rotary veneer. The plant layout provides for eventual expansion to include a rotary lathe and drier. The Forest Utilization Service had been promoting the use of larch for veneer since 1946.

4. Thirty specialists were trained in good sawmilling and lumber handling practices at a demonstration held at Moscow, Idaho, April 12-14. This was the fourth of a series of such demonstrations of the past year in the northern Rocky Mountain area. Unlike previous meetings at Darby, Superior, and Kalispell, Montana, this course was planned to train future instructors. Extension foresters from three states, representatives of the Idaho and Montana forestry schools, and Forest Service personnel attended the demonstration. A sawmill specialist of the Forest Products Laboratory, Madison, Wisconsin, conducted the training under the auspices of the Idaho Extension Service. Demonstrations we have had to date indicate that small sawmill operators have a great need for instruction in the art of grading lumber. The new group of instructors will be able to do a great deal of good among this group.

5. Tentative conclusions of the J. Neils cooperative air seasoning study of lodgepole pine telephone and power poles indicate a seasoning period of 3 to 9 months to be desirable in the western Montana area. Poles put in the pile in June will season in three months or less, depending on the character of summer weather. It was found that the maximum period of nine months would be required for poles put in the pile in early or middle fall.

The demand for lodgepole pine poles continues to increase and during 1950 over 400,000 poles were produced. Most of these were produced in the northern Rocky Mountain area. Experience of the industry to date has indicated that moisture content is a critical factor in the preservative treatment of these poles. As a result of this study we now have the basis for determining the profitability of maintaining large inventories for seasoning periods averaging six months or longer as compared to seasoning poles by heat and pressure in the pressure retort.

Poles properly seasoned can be treated in from 8 to 12 hours. Green, unseasoned poles require a treating cycle of from 25 to 40 hours. This means typing up a $750,000 plant for three times as long when green poles are treated, as well as cutting down substantially on output during periods of high market demand.

6. Tentative specifications for western larch crossarms were developed. During the past six months an apparent shortage of Douglas-fir crossarm material has developed due to excessive demand for high quality Douglas-fir wood for many other purposes. Hence, producers have looked elsewhere for this material and western larch seems to be a logical species. Larch crossarms were first produced under the Douglas-fir specification, which does not seem at all applicable to larch because of differences in growth conditions and in physical nature of the wood. Mechanical strength properties developed by tests during the past six or seven years at the Forest Products Laboratory, Madison, Wisconsin, were applied to crossarm requirements and a set of tentative specifications developed.

7. Laboratory tests to determine pulp and paper making properties of the northern Rocky Mountain species were continued. Pulping tests of thinnings from a 45-year-old ponderosa pine stand were completed. The material came from a quality IV site near Newport, Washington. Kraft pulp from ponderosa pine thinnings was, in general, similar in sulfate-pulping characteristics and in strength of pulps produced to jack pine, a pulpwood of accepted and satisfactory quality.

   Samples of alpine fir pulpwood from four different locations were collected and sent to the Madison Laboratory for testing. They included wood from the following locations:

   (1) Old-growth timber from the pulp producing areas east of the Continental Divide in Montana. This material is intermingled with and adjacent to lodgepole pine.

   (2) Old growth from the headwaters of the Columbia on the Coeur d'Alene National Forest, where the trees are intermingled with or adjacent to stands of western white pine.

(3) Small trees ranging from 6 to 12 inches in diameter from the released understory of a larch--Douglas-fir forest in the Kalispell area of western Montana.

(4) Material from 6 to 12 inches in diameter not released by cutting and from the understory of the larch--Douglas-fir forest in the vicinity of Kalispell in western Montana.

B. Plans for 1952

1. The air seasoning study of lodgepole pine telephone and power poles will be completed and another phase of the study started on western larch poles. The final report on the lodgepole pine pole air seasoning study will be completed the forepart of the year. Preliminary work for the erection of larch pole seasoning piles will be finished by June. It is expected that several types of piles will be erected during the summer at the J. Neils Lumber Company, Libby, Montana. Possibilities of poisoning larch pole trees and partially seasoning them on the stump will be determined at the Priest River Experimental Forest.

2. Further study of utilization possibilities of dead lodgepole pine is proposed. In cooperation with the Forest Products Laboratory, the Divisions of Pathology and Entomology, and the administrative branch of the Forest Service, we will review work done to date on utilization of dead lodgepole pine. In addition, we plan further research to determine rate of deterioration and value for pulping of insect-killed material of various ages.

3. Utilization of Douglas-fir throughout its inland range is proposed for study. Encroachment of Douglas-fir on pine sites has created serious utilization problems throughout the forests of eastern Washington, north Idaho, and Montana. Douglas-fir growth habits and characteristics, and problems created by this species, will be surveyed. Secondly, a long-term cooperative study by the Northern Rocky Mountain Forest and Range Experiment Station and the Forest Products Laboratory will be developed to determine (a) relationship of growth condition to wood quality, and (b) possibilities of improving quality by growth control or other methods.

4. Results of recent pulping tests of northern Rocky Mountain species will be made available. Reports on Forest Products Laboratory pulping tests of thinnings of ponderosa pine, western larch, and several variations of alpine fir will be distributed to interested agencies and individuals and also discussed at various meetings, and with interested companies.

5. Efforts will be continued to apply results of research at the Forest Products Laboratory through cooperative relations with interested individuals and agencies. Some of the groups we expect to work with are:

1. Northwest Wood Products Clinic. Assist in program development and meetings.

2. Forest Products Research Society. Assist in program development and meetings.

3. American Wood Preserver's Association. Inspect 40-year-old western redcedar pole lines of Montana Power Company and Chicago, Milwaukee, St. Paul & Pacific Railroad Company with pole service committee.

4. Regional national forest administrative organization.

5. Western Pine Association and individual members.

6. Industrial Development Division, Montana State Chamber of Commerce.

7. Timber Products Bureau, Spokane Chamber of Commerce.

8. Pole Committee, American Standards Association.

FLOOD CONTROL SURVEYS

A. Accomplishments in 1951

During the year emphasis was directed toward assembling basic information necessary for the first phase of the flood control and Comprehensive Agricultural Program reports for the Columbia Basin. According to the time table set up for the Columbia Basin report this was to be our last full field season; therefore, field work was pushed ahead as rapidly as possible in order that a maximum amount of basic data might be available for analysis and inclusion in the report.

Guide lines were drawn up by the USDA Field Committee for the Columbia River Basin report. At present, plans call for three reports:

1. The Comprehensive Agricultural Program Report for the entire Basin.

2. Supplemental reports for four watersheds within the Basin.

3. A work plan for the first year's program.

Flood Control Survey of the Columbia River Basin

1. Estimated average annual damages in the NRM area of responsibility total slightly over 2 million dollars (1949 values), including flood plain damages collected by the Army, but excluding cropland damages collected by SCS. These are all direct monetary damages to cultural improvements. Damages to the basic natural resources such as soil, desirable stream channel characteristics, etc., have not yet been evaluated, nor have indirect damages been estimated. Our area of responsibility includes Montana west of the Continental Divide, the 10 north Idaho counties, and 3 northeast Washington counties. Summaries show average annual damages by states, supplemental report areas, by certain major watersheds, and for six sample watersheds. Data were also collected on three or more floods on each sample watershed in order to establish stage-damage curves. Types or categories for which damages were tabulated are: railroads, state and federal highway systems, county roads, roads and trails on national forest and other federal lands, public utilities (including communication and transmission systems), urban, and industrial.

   The Army Corps of Engineers has made studies of flood damages along the flood plains of the lower Kootenai and lower Pend Oreille rivers, including estimates of damage reductions due to projects under construction or approved for construction. We used these data in making summaries of annual damages.

   Our damage data have been correlated with the SCS agricultural damages within our area of responsibility and with damages collected by other stations in adjoining areas.

2. Cooperation was given in preparing the capital investment phase of the Columbia Basin report. During the year the division actively participated with National Forest Administration in collecting program material for national-forest lands in Region One. This program material was then used as a basis for determining program needs for all lands under the jurisdiction of other federal agencies, state ownerships, and private forest ownerships in the upper Columbia Basin. A Flood Control-NFA task force was created to work as a team in gathering this material. Except for the national parks and Fish & Wildlife Service program material, the capital investment collection job is complete.

3. A cover condition survey was completed for six sample tributary watersheds in the upper Columbia area. This survey covered approximately 4½ million acres of the upper Columbia unit. Factors such as aspect, slope, elevation, cover composition and density, and land use were considered, as well as litter, humus, and soil depth. Soil texture, amount of low ground cover, evidence of sheet erosion, road and trail erosion, streambank cutting, and channeling were also noted.

   This field information was transcribed to approximately 4,500 punch cards and then tabulated by various combination of conditions. A unique method of card counting was developed and used in tabulating the data. A sensitive dietetic scale was calibrated to read card numbers directly. This method of card counting reduced compilation time many fold. When analyzed, these data will be used in hydrologic and economic evaluations of the Basin.

4. Land ownership and classification tabulations were completed for the upper Columbia area. Tabulations showing acres by ownerships by forest and range types for the upper Columbia area were completed during the year. The forest land tabulations have been coordinated with other agencies and are in final form. Further coordination is needed on range and cropland acreages before final tables can be processed. All tabulations were based upon Forest Survey data adjusted to reflect recent ownership changes and grouped to show general type delineations.

   Some interesting results are as follows:

Upper Columbia Basin

Unit III

	Idaho 1/	Montana 2/	Northeast Washington 3/
a. Percent of total area in forest land	83	81	75
b. Percent of total forest land administered by Forest Service	62	62	31
c. Percent forest land administered by public agencies	72	76	56
d. Dominate forest types (percent):			
Western white pine	36	-	-
Larch--Douglas-fir	19	32	26
Ponderosa pine	16	17	44
Lodgepole pine	-	24	-

1/ Includes Clearwater, Spokane, and Clark Fork drainage area in Idaho.
2/ Includes Clark Fork, Kootenai and St. Marys (Hudson Bay) drainage area in Montana.
3/ Includes Pend Oreille, Spokane, Ferry, and Stevens Counties in Washington.

This upper Columbia area contains over 51,370 square miles. Over 80 percent of this vast area is classified as forest land.

5. Peak flow, flood frequencies, and other hydrologic data were collected and compiled. In cooperation with the SCS the compilation of past flood records on gaged tributary streams has been completed for the Montana portion of the Columbia Basin and data are being collected for northern Idaho and northeast Washington.

Cover, slope, and aspect measurements have been completed on 20 SCS snow courses located in the higher elevated mountains of the upper Columbia River Basin (U. S. portion).

6. A basin-wide reconnaissance and inventory of potential reservoir sites was started by midsummer. By far the greater amount of information collected has been secured from the Montana State Water Board and the Idaho Department of Reclamation. Additional

data are to be obtained from the U. S. Bureau of Reclamation. Field reconnaissance has been confined to areas within the upper Basin not already covered by other agencies.

7. Preliminary write-ups for the Comprehensive Agricultural Program report were prepared. Many sections and items of the report were assigned to the division for processing, such as material relating to location and size, physical and biological conditions, erosion and sedimentation, and land cover characteristics of the Columbia Basin. The division prepared a statement on watershed problems for forest and range lands, water yields, pollution, and flood sedimentation damages for the Comprehensive Agricultural Program.

8. Reconnaissance soil studies, begun on the Lochsa and Colville sample watersheds in 1950, were finished and reports prepared by June 1951. Most of the field work on two other sample watersheds--the Bitterroot and Coeur d'Alene--was done in 1950. Because of time limitations, it appears that any further soils information needed to complete the report will have to be gleaned principally from secondary sources.

Supplemental Advance Flood Control Studies

9. Weekly observations of precipitation catch by four test gages continued to indicate consistent differences which point to the need for improved methods of precipitation measurement. Accurate measurement of precipitation, especially snow, is one of the many problems associated with current studies of snow and runoff in relation to vegetal cover. The battery of gages installed in 1949 on a windy, south-facing, 22-degree slope at elevation 5500 at Priest River was operated through 1951. The test installation included:

   (1) Recording gage with "stereo" orifice extension and tilted shield.

   (2) Recording gage with horizontal orifice and shield.

   (3) Non-recording gage with "stereo" orifice.

   (4) U. S. Weather Bureau non-recording gage with funnel removed (horizontal orifice).

   The following table summarizes two years' catch by the test gages, numbered as above:

Precipitation Catch (Inches)

Gage	Nov. 7, 1949 to Nov. 6, 1950	Oct. 1, 1950 to Oct. 1, 1951
(1)	65.23	60.86
(2)	54.38	51.03
(3)	40.09	35.75
(4)	27.36	26.98

The stereo gage (1) with tilted shield is presumed to be the most accurate. Gage catch has not yet been successfully related to changes in amount of precipitation as indicated by snow pack water equivalents, principally because of the unmeasured effect of rain and wind on the snow pack. The effects of wind on differences in catch among the four gages is also difficult to determine due to deficiencies of cup-wheel type anemometers under winter conditions.

10. Snow accumulation and melt data were collected over a wide range of cover intensities. Eighteen special snow courses were measured throughout the late winter and spring of 1951 to supplement similar data being collected at the Priest River Experimental Forest. The operation of these courses has permitted us to cover a greater range of cover intensities than found at the present Priest River installations.

11. Cover intensity as it appears to influence snow accumulation and melt was measured with a "ceptometer" at 16 of the above-mentioned special snow courses, 20 SCS snow courses, and the recently operated Priest River courses. The ceptometer was developed as a device for measuring the intensity of cover at a particular point. Preliminary analysis of cover intensity data measured with the ceptometer indicates that a significant correlation of these data with snow accumulation and melt can be expected.

The ceptometer is an adaptation of the "Moosehorn" crown closure estimator described by George A. Garrison in the September 1949 issue of the Journal of Forestry. A curved mirror in the ceptometer gives a field of view extending 45° in all directions from the vertical. The intensity county is, therefore, made within a space bounded by an inverted 90° cone with apex at the instrument. The grid used is divided into quadrants and circles representing cones with apex angles of 30, 60, and 90 degrees. Further analysis of data collected should determine whether or not fully adequate and pertinent measurements can be made with the device and if the range of the ceptometer covers the major area of influence. It has already been observed that snow accumulation in relatively small stands of timber in open, windy country behaves differently than it does in the areas largely timber covered.

12. Plans for conducting snow-melt studies at the Upper Columbia Snow Laboratory were prepared. After five years of continuous operation, the Corps of Engineers closed the snow laboratory in June 1951. Their principal interest had been to correlate weather and snow pack on the watersheds with flood peaks and volume of runoff. To this end they accumulated continuous meteorological records at several locations, operated stream gages on two watersheds, and measured numerous snow courses through each winter and spring. The buildings and equipment were made available to the station on a loan basis giving us an opportunity to collect data on the influence of various types and densities of vegetation on snow accumulation and melt. Such data will be useful in evaluating the hydrological effects of the land treatment program as proposed in the flood control survey and the Columbia Basin Comprehensive Agricultural Plan, and will provide preliminary data and information on field techniques for use in future Forest Influences research.

13. The striking story of erosion, flood, and destruction that occurred when the Mann Gulch burn was struck by a heavy thunderstorm in the summer of 1950 was prepared in words and pictures. This story was published in July 1951 as Research Note No. 102 under the title "Forest Fire--Thunderstorm, Knockout Combination for Watersheds." Seldom are harmful effects of a forest fire upon a watershed as promptly and dramatically demonstrated as in the case described. Summer thunderstorms, falling on an area severely burned a year before, gutted stream channels, washed out roads and bridges, carried away topsoil, destroyed recreational and aesthetic values, and caused other striking damages. Adjacent, unburned areas in the path of the storm remained unharmed. The story is documented by before and after measurements of channel cross-sections and 18 photographs, including 4 sets of before-and-after pictures.

B. Plans for 1952

1. Survey of the Columbia River Basin will be continued. Primary efforts will be pointed at completing the division's Basin planning assignments.

   Compilation and analysis of damage, land use, and cover surveys and hydrologic data are to be completed and integrated for use in the development of the Basin program as well as current programs. The inventory of reservoir sites is planned for completion by late spring.

2. Supplemental studies needed for interpretation of Basin-wide conditions will continue.

   Advance studies will continue at Priest River with minor change in instrumentation and collection of data. More emphasis is being placed on snow evaporation and frost studies. Further attempts to determine wind effects and to compare gage catch of precipitation with snow pack water equivalent are in progress during the current winter season. Analysis of data on hand and

to be collected will be given high priority for use in completing the Columbia Basin Survey.

Advance studies to be undertaken at the Upper Columbia Snow Laboratory will continue through the coming snow accumulation and melt season. Studies made will supplement data taken at Priest River on snow accumulation and melt and allied influences. Records from Colman soil moisture units previously installed at the laboratory will be continued. Work has been programmed to permit maximum use of field data in the Columbia Basin Survey.

Some additional snow accumulation and melt data will be collected to further supplement observations taken at Priest River and the snow laboratory.

DIVISION OF WILDLIFE RESEARCH[1/]

A. Accomplishments in 1951

1. Studies by means of fenced and unfenced plots on the Kootenai National Forest showed that deer have destroyed many tree seedlings. The series of seven deer exclosure plots are located on areas which are heavily browsed by deer in the winter time. Five years after plot establishment the following numbers of naturally established tree seedlings were found:

	Exclosures	Unfenced check plots
Ponderosa pine	114	18
Douglas-fir	197	68

During 1951 a station research note was published which reported the results. Personnel from the Kootenai National Forest, Montana Fish & Game Commission, and the station's Division of Forest Management Research have assisted in the project.

2. The study of effect of simulated deer browsing on ponderosa pine seedlings was continued. In order to get a reliable basis for evaluating the effect of browsing upon small pine trees, a series of trees are being artificially clipped according to a regular scale of intensities and a schedule of times over a period of five years. The study has now been underway four years and the seedlings are beginning to show graduated responses to different intensities of browsing. The Montana State University's Cooperative Wildlife Unit and the station's Division of Forest Management Research have aided in carrying on the study.

1/ Maintained at the Northern Rocky Mountain Experiment Station by the U.S. Fish & Wildlife Service. Currently the Biologist, Mr. Lowell Adams, is on educational leave at Johns Hopkins University. Meanwhile, scheduled parts of the wildlife research program are being carried on by the Cooperative Wildlife Unit at Montana State University and the station's Division of Forest Management Research.

3. The small mammals populations study showed that seed-eating mice and shrews remained at low levels during 1951. The population studies are being conducted on Deception Creek Experimental Forest and the Kootenai National Forest. In the Kootenai study areas, the population trend has paralleled ponderosa pine seed production for three years. The strength of the relationship between mouse numbers and pine seed may be demonstrated in the spring of 1952 following the relatively large pine seed crop in the fall of 1951.

4. The analysis of data on frequencies of porcupine scars on lodgepole pine in Montana and Wyoming was continued. The purpose of the study is to establish relationships between numbers of scars and porcupine population changes. Currently, some revised analyses are in progress following advice from the Department of Biostatistics, Johns Hopkins University.

5. A study of technique for quantitative estimation of the food eaten by herbivores, particularly snowshoe hares, was begun. The study is part of a larger program concerning the effects of nutrition on wild populations. The project was developed in cooperation with the Flathead Biological Station of Montana State University and with the Vertebrate Ecology Division of Johns Hopkins University.

B. Plans for 1952

1. The deer and small mammals programs will be continued. Currently, they are on routine maintenance schedules that require attention each spring and fall. Measurements and treatments will be undertaken as scheduled for 1952.

2. Expand the snowshoe hare project to include research on a technique for censusing hares by fecal pellet counts. It is expected that with a quantitative food technique and census technique, both based on fecal analyses, it will be possible, by a single sampling job, to estimate (1) the number of hares, (2) the plant species being eaten, and (3) the amount of each plant species being eaten.

DIVISION OF FOREST PATHOLOGY[2/]

Research by the Division of Forest Pathology in this region is limited almost entirely to the pole blight disease of western white pine. As previously pointed out, pole blight studies are cooperative between the division, University of Idaho, the Dominion Laboratory of Forest Pathology (Canada), and the Forest Service.

A. Accomplishments in 1951

1. The range of the pole blight disease has been reasonably well established. Initial surveys of the pole blight disease have been completed. All known pole stands of white pine in the Inland Empire region have been checked from the air and on the ground by survey crews for the presence of pole blight. Data from the past summer's work is yet to be compiled. Within the past year, pole blight has been discovered on Vancouver Island, B. C., establishing for the first time its presence on the West Coast. Whether the scattered white pine stands of Washington and Oregon in the Cascade Mountain Range have already or will become infected is yet to be determined.

2. Field inoculation of white pines, which has been under way for the last three years, has been completed. Approximately 500 trees have been treated in various ways with the most promising fungi isolated from diseased trees. An observation period of from seven to ten years may be necessary before the effects of the inoculations and their significance can be determined.

3. Study of the relation of wood lesions and resinosis to the pole blight complex were continued. The principal objective of this work is to establish whether lesions and resinosis--apparently invariable symptoms of pole blight--precede or follow the marked reduction of growth in diseased trees. During 1951 lesions and resinosis were diagrammed to scale on 22 trees. About 30 sample sections were cut from each tree and were brought into the laboratory for further dissection and study. Results of analysis are not yet completed.

4. Physiological studies of the most suspicious fungus (Leptographium sp.) associated with pole blight were initiated during the year. This work should aid in separating the pathogenic species from a number of saprophytic but morphologically similar forms.

5. A small test designed to show whether or not topping of blighted trees would check the progress of the disease in them was made on the Coeur d'Alene National Forest.

2/ Maintained at the Northern Rocky Mountain Experiment Station by the Bureau of Plant Industry, Soils, and Agricultural Engineering.

B. Plans for 1952

Observations will be continued on (1) inoculated trees, (2) fertilizer studies installed in previous years, and (3) topping studies. Physiological studies of Leptographium will be continued. If analyses of lesion specimens on hand show a need for it, additional dissections will be made. Surveys will be continued and concentrated on certain critical pole-blighted areas. If funds and personnel are available, a virus study and a soils-physiology study will be initiated.

PUBLICATIONS ISSUED DURING 1951

Northern Rocky Mountain Station

Publications of the Northern Rocky Mountain Forest and Range Experiment Station, 1912 through 1950. Station Paper No. 31. 69 pp. July.

Division of Forest Economics

Division of Forest Economics

Research Hi-Lites, vol. III, No. 5 (March) and No. 15 (August).

Finch, Thomas L.

How fast is timber growing in eastern Montana? Research Note no. 88. 7 pp. February.

Huey, Ben M.

Montana Christmas tree shipments drop slightly. Research Note no. 86. 3 pp. January.

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Relation between the consumption of round timber and the production of ore in the metal mines of the northern Rockies. Research Note no. 94. 3 pp. March.

Metcalf, Melvin E.

Importance and causes of timber mortality in eastern Montana forests. Research Note no. 93. 4 pp. March.

Wikstrom, John H.

1950 pulpwood production drops. Research Note no. 90. 1 p. February.

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Pole production down in 1950. Research Note no. 101. 3 pp. June.

Division of Forest Management Research

Division of Forest Management Research

Research Hi-Lites, vol. III, No. 9 (May) and No. 16 (October).

Boe, Kenneth N.

Natural regeneration of lodgepole pine on seedbeds created by clear cutting and slash disposal. Research Note no. 99. 1 p. May.

Foiles, Marvin W.

Results of poisoning western hemlock. Northwest Science XXV(1):41-47. February.

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Results of seeding germinated western white pine seed. Research Note no. 95. 5 pp. April.

Foiles, Marvin W.
Test of seeding germinated western white pine seed. Tree Planters' Notes no. 8. November:10-11.

Lynch, Donald W.
Diameter growth of ponderosa pine in relation to the Spokane pine-blight problem. Northwest Science 25(4):157-163. November.

_____ and Chapman, Roy A.
Sampling in tree measurement sales on northern region national forests. Station Paper no. 27. 47 pp. April.

Polk, R. Brooks, and Boe, Kenneth N.
Succession of trees in cut-over larch--Douglas-fir stands in western Montana. Proc. Montana Acad. Sciences (10):31-37. 1951.

Roe, Arthur L.
Growth tables for cut-over larch--Douglas-fir stands in the Upper Columbia Basin. Station Paper no. 30. 24 pp. June.

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Growth tables for selectively-cut ponderosa pine in western Montana, Station Paper no. 32. 18 pp. September.

Shaw, Charles Gardner, Fischer, George W., Adams, Donald F., Adams, Mark F., and Lynch, Donald W.
Fluorine injury to ponderosa pine: a summary. Northwest Science 25(4):156. November.

Thompson, Kenneth and Adams, Lowell
Use statistics in wildlife research. Pittman-Robertson Quarterly, 10(4):526-530. 1950. (Issued too late for reporting in 1950.)

Watt, Richard F.
Snow damage in a pole stand of western white pine. Research Note no. 92. 4 pp. March.

Wellner, C. A.
Conservation influences of forest management. Idaho Conservation Source Book. (Edited by Harry C. Caldwell.) Pp. 93-98. Univ. of Idaho. 1951.

_____ and Foiles, M. W.
What to see and where to find it on the Deception Creek Experimental Forest. Misc. Pub. no. 2. 72 pp. May.

_____, Watt, R. F., and Helmers, A. E.
What to see and where to find it on the Priest River Experimental Forest. Misc. Pub. no. 3. 86 pp. May.

Division of Range Research

Division of Range Research
The Northern Great Plains Research Center - its work and aims. Misc. Pub. no. 1. Partly revised in May 1951.

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Research Hi-Lites, vol. III, no. 2 (January), no. 4 (February), no. 6 (March), no. 8 (April), no. 10 (May) no. 12 (June), no. 14 (July), no. 17 (October) and December 18 issue.

Evanko, A. B.
Response of Wyethia to 2,4-D. Research Note no. 98. 7 pp. April.

Harris, Grant A.
St. Johnswort on western ranges. Station Paper no. 26. 18 pp. February.

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St. Johnswort (goatweed) on western ranges. Montana Stockgrower 23(5): 10. May 15. (Rerun of Station Paper no. 26.)

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A selected bibliography of range management literature published in 1950. Bibliography, v. 1, no. 5. September.

Hurtt, Leon C.
Managing northern Great Plains cattle ranges to minimize effects of drought. U.S.D.A. Circ. no. 865. 23 pp. March.

Reed, M. J.
It grows like a weed but -- equals alfalfa for feed. Montana Farmer-Stockman, May 1, pg. 8.

Woolfolk, E. J.
Crested wheatgrass grazing values. Research Note no. 91. 10 pp. March.

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$10,000 worth of beef from $200 worth of crested wheatgrass seed -- a report of an 11-year test of what crested wheat can do. Montana Farmer-Stockman, Aug. 1, pg. 52. (Digest of Research Note no. 91.)

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Crested wheatgrass grazing values. Montana Stockgrower, 23(5):62. May 15. (Rerun of Research Note no. 91.)

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Crested wheatgrass grazing values. Cattleman, XXXVIII(2):110. July. (Rerun of Research Note no. 91.)

_____ and Harris, G. A.
Forage species and seasons for reseeding foothill range lands in northeastern Washington. Research Note no. 97. 2 pp. April.

Division of Fire Research

Division of Fire Research
Research Hi-Lites, vol. III, no. 3 (February) and no. 13 (July).

Barrows, J. S.
Forest fires in northern Rocky Mountains. Station Paper no. 28, 251 pp. April.

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Fire behavior in northern Rocky Mountain forests. Station Paper no. 29, 103 pp., tables. May.

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Lightning fires in the northern Rocky Mountains. Fire Control Notes, 12(3):24-28. July.

Fahnestock, George R.
Correction of burning index for the effects of altitude, aspect, and time of day. Research Note no. 100. 4 pp., tables. June.

Forest Utilization Service

Forest Utilization Service
Research Hi-Lites, vol. III, no. 1. Sawdust should go back to the soil. 9 pp. January.

Research Hi-Lites, vol. III, no. 11. Wood molasses for livestock food. 9 pp. June.

Anderson, I. V.
Lignin for golf greens and other horticultural uses. Research Note no. 87. 4 pp. January.

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Industrial development of Montana's forests. Montana Affairs (house organ of Montana Chamber of Commerce). September.

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Valuation of ponderosa pine stumpage by use of tree grades. Paper delivered at second annual conference of Inland Empire Section, Forest Products Research Society, Sandpoint, Idaho. Sept. 27. (Reprint by Forest Products Research Society, 12 pp.)

Forest Utilization Service
Review of tie specifications and prices in the northern Rocky Mountain area as of December 1951. 2 pp.

Mueller, Lincoln A.
Suitability of western larch for veneer and plywood production. Research Note no. 96. 3 pp. April.

Division of Flood Control Surveys

Division of Flood Control Surveys
Research Hi-Lites, vol. III, no. 7 (April).

Friedrich, C. Allan
Forest fire -- thunderstorm, Knockout combination for watersheds. Research Note no. 102. 15 pp. July.

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Suggestions for manufacture and operation of a six-inch infiltrometer ring. Research Note no. 104. 3 pp. July.

Division of Wildlife Research

Adams, Lowell
White-tailed deer browsing on ponderosa pine plantations. Research Note no. 89. 5 pp. February.

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White-tailed deer browsing on natural conifer seedlings. Research Note no. 105. 3 pp. September.

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Confidence limits for the Peterson or Lincoln Index used in animal population studies. Jour. Wildlife Management, 15(1):13-19. January.

Division of Forest Pathology

Gill, Lake S., Leaphart, Charles D., and Andrews, Stuart R.
Preliminary results of inoculations with a species of Leptographium on western white pine. Forest Pathology Special Release no. 35. 14 pp., illus. U.S.D.A., B.P.I.S.A.E., Div. Forest Pathology. June.

DEPARTMENTAL PUBLICATIONS PLANNED FOR F. Y. 1952

Hutchison, S. Blair and Kemp, Paul D.
Forest Resources of Montana. U.S.D.A. Misc. Publ.

Roe, Arthur L.
Growth of selectively-cut ponderosa pine stands in the Upper Columbia Basin. U.S.D.A. Misc. Publ.--Handbook series.

Short, L. R. and Woolfolk, E. J.
Revision Farmers' Bulletin 1924, "Reseeding to increase the yield of Montana range lands"

DEPARTMENTAL PUBLICATIONS PLANNED FOR F. Y. 1953

Holscher, C. E. and Woolfolk, E. J.
Forage utilization by cattle on northern Great Plains ranges. U.S.D.A. Circular.

Moss, V. D. and Wellner, C. A.
Aiding blister rust control by silvicultural measures in the western white pine type. (Will be published by BE&PQ.)

Wellner, C. A. and LeBarron, Russell K.
Silvicultural management of western white pine forests. Tech. Bull.

Woolfolk, E. J. and Friedrich, C. A.
Reseeding formerly plowed range land in central Montana. U.S.D.A. Circular.

OTHER PUBLICATIONS PLANNED FOR RELEASE IN CALENDAR YEAR 1952

Division of Forest Economics

North Idaho forest and industry statistics. Station Paper.

Resource factors affecting pulp-mill feasibility in Eastern Montana. Station Paper.

Lumber production approaches all-time record for Northern Rocky Mountain Region, 1950. Research Note.

Montana Christmas tree production, 1951. Research Note.

Pole production, 1951. Research Note.

Pulpwood production, 1951. Research Note.

Dickerman, M. B. and Hutchison, S. Blair
Montana's timber base for industrial growth. Montana Academy of Science.

Hutchison, S. Blair
Timber industry expansion and stream pollution in the Northern Rocky Mountain States. Northwest Science.

Division of Forest Management Research

Bingham, R. T., Duffield, J. W., and Squillace, A. E.
Breeding blister rust resistant western white pine. Journal of Forestry.

Boe, Kenneth N.
Seed germination and early seedling survival of lodgepole pine on different seedbeds in clearcuttings. Proc. Mont. Acad. Sciences.

_____ and Roe, A. L.
A successful lodgepole pine direct seeding project. Research Note.

Division of Forest Management Research
Research Hi-Lites. Two issues.

Foiles, Marvin W.
Results of a 15-year test of thinning in the western white pine type. Research Note.

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Results of a 35-year test of thinning in the western white pine type. Research Note.

Lynch, Donald W.
Growth predictions for second-growth ponderosa pine in northeast Washington. Station Paper.

_____ Planting guide for northeast Washington. Misc. Publication—Station series.

Northern Rocky Mountain Forest Genetics Steering Committee
Specifications for selection of superior parent trees. Research Note.

Pole Blight Investigations Steering Committee
Pole blight—what is known about it. Misc. Publication—Station series.

Post, Andrew J.
Results of a 30-year test of thinning in the western white pine type. Research Note.

Roe, Arthur L.
Cost of seedbed preparation in larch type. Research Note.

_____ Seed dissemination from the edge of a larch stand. Research Note.

_____ Larch—Douglas-fir regeneration studies in Montana. Northwest Science.

_____ and Squillace, A. E.
Effect of cutting methods on logging costs in larch—Douglas-fir. Journal of Forestry.

_____ preparation required for larch reproduction. Research Note.

Squillace, A. E.
Opportunities for forest genetics research in the northern Rocky Mountain Region. Proc. Mont. Acad. Sciences.

Watt, Richard F.
Composition and site index changes in immature stands of the western white pine type. Research Note.

_____ Growth in immature stands of the western white pine type. Journal of Forestry.

Watt, Richard F.
Mortality in immature stands of the western white pine type. (Publication outlet not yet determined.)

Wellner, C. A.
Effects of tree vigor on growth and mortality in mature western white pine. Northwest Science.

_____ and Evenden, J. C.
Vigor classification for mature western white pine in the Inland Empire. Research Note.

Division of Range Research

Evanko, A. B.
Forage species and seasons for reseeding cut-over ponderosa pine lands in northeastern Washington. Research Note.

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Sierra larkspur and 2, 4-D. Research Note.

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Forage species and seasons for reseeding burned lodgepole pine area in northeastern Washington. Research Note.

_____ and Peterson, R. A.
Some effects of grazing on vegetation and soils on mountain ranges. Journal of Ecology or Journal of Range Management.

_____ and Schmautz, J. E.
The effectiveness of rogueing and herbicides sprays in controlling Wyethia. (Probably in Journal of Range Management.)

Peterson, R. A.
Comparative effects of pretreatment of seed upon seedling emergence in seven browse species. Research Note or Station Paper.

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Response of forage plants in a high altitude nursery. Journal of Range Management or Research Note.

Reed, M. J.
More about Belvedere summercypress. Montana Farmer-Stockman.

Schmautz, J. E.
Improving Wyethia infested ranges by spraying and reseeding. Journal of Range Management or Research Note.

Short, L. R.
The relationship between plant heights inside and outside pricklypear cactus clumps--a c ue to range condition. Journal of Range Management.

Woolfolk, E. J.
Montana range lands. Montana Kaimin, 1952.

Division of Forest Utilization Service

Anderson, I. V.
Violin woods of the northern Rocky Mountain area. Research Note.

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Industrial development of Montana's forest resource. Cooperative publication.

Division of Flood Control

Helmers, Austin E.
Precipitation measurement on wind-swept slopes. (To be published in Northwest Science magazine and possibly in Transactions of American Geophysical Union.)

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Influence of altitude and aspect on snow accumulation and melt. Station Paper.

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Some effects of forest cover on the interception and melting of snow. Station Paper.

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An anemohygrothermograph. Station Note. (Possibly Journal of Forestry, briefer articles and notes.)

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Response of a mountain spring to precipitation and snow melt. Station Note.

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A few soil moisture and temperature cycles. Station Note.

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Snow studies across a mountain valley. Station Paper.

Smith, DeWilton C.
Some results of operation snow pack, 1949-50. Station Note.

Division of Wildlife Research

Adams, Lowell
Fifty years of porcupine cycles. (Outside publication.)

Wright, E. and Graham, D. P.
The pole blight surveys of 1950 and 1951. (To be published in the Journal of Forestry.)

PERSONNEL

Numerous changes in personnel took place during 1951 at the station and with some effect on accomplishments. Rising costs required a steady reduction in both technical and clerical staffs. A net of four less technical men and two less clerical employees were on the job at the year's end.

The Flood Control Survey division chief was transferred to another station during the year and will not be replaced. His work will be absorbed by the Forest Economics division chief. A soil specialist position was eliminated also during the year.

The Division of Forest Economics experienced a number of changes during 1951. A new division chief was appointed in midyear. Three technical staff men resigned or were transferred to other stations. Shortage of funds prevented replacing the three men, also one clerk. As a consequence in contrast with 10 permanent full-time workers at the beginning of 1951, the division ended the year with 6.

One of the two technical men in the Forest Utilization Service was transferred and cannot be replaced with present funds.

The Fire Research Division added two technical men, with help from National Forest Administration, to increase the staff to three.

One assistant project leader in Range Research went on educational furlough but was replaced by a junior grade technician.

The cooperating biologist of the Fish & Wildlife Service is on educational leave and that program of work is on a maintenance basis.

A number of other transfers and replacements, particularly in the clerical organization, have been necessary. The station roster as of December 31, 1951, follows:

OFFICE OF DIRECTOR

George M. Jemison	Director
Mary J. Pershina	Administrative Assistant
S. Dagmar Nelson	Clerk
Sylvia M. Harris (resigned 1-18-52)	Clerk-Stenographer

DIVISION OF FOREST MANAGEMENT RESEARCH

Russell K. LeBarron (Chief)	Forester (For. Man. Res.)
Marie Van Loon	Clerk-Stenographer

DIVISION OF RANGE RESEARCH

E. Joseph Woolfolk (Chief)	Range Conservationist
Merton J. Reed	Range Conservationist
Mary C. Bowler	Clerk-Stenographer

DIVISION OF FOREST ECONOMICS

Harry W. Camp, Jr. (Chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Paul D. Kemp	Forest Economist
Thomas L. Finch	Forester (Mensuration)
John H. Wikstrom	Forester (Mensuration)
Henry J. Pissot	Forestry Aid (Research)
Monica E. Hobe	Clerk-Stenographer

DIVISION OF FLOOD CONTROL SURVEYS

Harry W. Camp, Jr. (Chief)	Forest Economist
Paul A. Ingebo	Hydrologist
George F. Weyermann	Forester (For. Inf.)
C. Allan Friedrich	Forester (For. Inf.)
Austin E. Helmers	Forester (For. Inf.)
Gordon A. Hutton	Forester (For. Inf.)
DeWilton C. Smith	Forester (For. Inf.)
Robert S. Mathison	Research Forester
Ludvik Rosich	Physical Science Aid
Katherine E. Lamoreaux	Clerk-Stenographer
Joanne C. Orvis	Clerk-Stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (Chief)	Forester
Hilda C. Griffiths	Clerk-Stenographer

DIVISION OF FOREST FIRE RESEARCH

Jack S. Barrows (Chief)	Forester (Fire Res.)
George R. Fahnestock	Forester (Fire Res.)
Charles E. Hardy	Forester (Fire Res.)
Edna H. Campbell	Clerk-Stenographer
Kenneth M. Macdonald	Collaborator

INLAND EMPIRE RESEARCH CENTER

Charles A. Wellner (Leader)	Forester (Res. Adm.)
Donald W. Lynch	Research Forester (Gen.)
Anthony B. Evanko	Range Conservationist
Marvin W. Foiles	Forester (Silv.)
Richard F. Watt	Forester (Silv.)
Vandella I. Gordon	Clerk-Stenographer

UPPER COLUMBIA RESEARCH CENTER

Arthur L. Roe (Leader)	Forester (Silv.)
Roald A. Peterson	Range Conservationist
Kenneth N. Boe	Forester (Silv.)
Anthony E. Squillace	Forester (Silv.)
Marie Van Loon	Clerk-Stenographer

FIELD STATIONS

Deception Creek	(Coeur d'Alene, Idaho)	Marvin W. Foiles, In Charge
Priest River	(Priest River, Idaho)	Austin E. Helmers, In Charge
Coram	(Coram, Mont.)	Anthony E. Squillace, In Charge
Northern Plains	(Miles City, Mont.)	Laurence R. Short, In Charge
Vigilante	(Alder, Mont.)	Jack E. Schmautz, In Charge

FOREST PATHOLOGY

(In cooperation with Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering):
Charles D. Leaphart, Missoula, Montana

FOREST WILDLIFE

(In cooperation with Fish and Wildlife Service, Department of Interior):
Lowell W. Adams, Missoula, Montana

FOREST INSECT CONTROL

(In cooperation with Bureau of Entomology and Plant Quarantine):
James C. Evenden, Coeur d'Alene, Idaho.

DIRECT AND INDIRECT COSTS BY FINANCIAL PROJECTS

F.Y. 1952

Financial Project	Indirect	Direct	Total
Forest & Range Management Inv.	$ 18,648 *	$137,999	$ 156,647
Forest Products Inv.	1,674	16,926	18,600
Forest Resources Inv.	5,085	51,415	56,500
Flood Control Surveys	6,654	67,276	73,930
Total	32,061	273,616	305,677

* Includes $5,000 for Hurtt's salary and expenses.

DISTRIBUTION OF DIRECT COSTS BY MAIN PROJECTS

F.Y. 1952

Financial and work project	Cars, Maintenance & new	Equipment, misc.	Travel Expenses	Salaries		Total
				Regular	Temp.	
	Dollars					
FOREST & RANGE MANAGEMENT INV.						
504	4,030	3,802	3,400	47,501	8,846	67,579
506	2,382	2,375	3,000	36,075	3,296	47,128
520	1,166	1,837	2,000	15,639	2,650	23,292
Total	7,578	8,014	8,400	99,215	14,792	137,999
FOREST PRODUCTS						
595	765	348	1,600	14,213		16,926
FOREST RESOURCES						
601	1,218	405	1,500	22,577	1,600	27,300
602	712	63	500	15,011	1,004	17,290
610	100	38	225	6,462		6,825
Total	2,030	506	2,225	44,050	2,604	51,415
FLOOD CONTROL SURVEYS						
703	3,047	574	5,000	50,030	8,625	67,276
Grand Total	13,420	9,442	17,225	207,508	26,021	273,616